Appendix C

Erosion and Runoff Calculations

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Engineering Design File

PROJECT FILE NO. 021048

Central Facilities Area Sewage Treatment Plant Drain Field (CFA-08) Protective Cover Water and Wind Erosion Calculations

Prepared for:
U.S. Department of Energy
Idaho Operations Office
Idaho Falls, Idaho

Idaho National Engineering and Environmental Laboratory

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ENGINEERING DESIGN FILE

1. Title: CFA Sewage Treatment Plant Drain Field (CFA-08)

2. Project File No.: 021048

3. Site Area and Building No.: CFA-08

4. SSC Identification/Equipment Tag No.:

5. Summary:

This Engineering Design File (EDF) contains the calculations for water and wind erosion rates for the Central Facilities Area Sewage Treatment Plant Drain Field (CFA-08) Protective Cover. The CFA-08 drain field was used for disposing the sewage treatment plant effluent from 1944 through 1995. During 1950-1995 a laundry facility, which cleaned low-level radionuclides from protective clothing, discharged radionuclide residues to the sewage treatment plant and drain field. As a result of the laundry operations, the soil in the drain field was contaminated with cesium-137. The Waste Area Group 4 (WAG-4) remedial investigation/feasibility study determined the cesium-137 contamination in the drain field poses a potential human health risk and the CFA Record of Decision (ROD) determined constructing an engineered soil cover is required for remediation. The protective cover will be an evapotranspiration type engineered barrier consisting of soil overlying layers of cobble rock and gravel. The soil for the cover top will come from Lincoln Blvd borrow source and the soil for the side-slopes will come from an approved on-site borrow source to be determined. The soil properties for the side-slopes shall be similar to those of Spreading Area A soils. Therefore, Spreading Area A soil properties were used for the calculation basis of this EDF for the side-slope materials.

6. Review (R) and Approval (A) and Acceptance (Ac) Signatures:
(See instructions for definitions of terms and significance of signatures.)

	R/A	Typed Name/Organization	Signature	Date
Performer		K. D. Fritz, P.E.	Kurt Fritz	3/4/02
Checker	R	S. L. Austad, P.E.	SLAustad	3/4/02
Requestor	A	D. J. Wagoner	D Wagoner	3/5/02

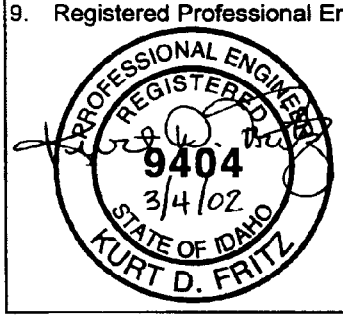
7. Distribution: (Name and Mail Stop) K. D. Fritz, MS 3650

8. Records Management Uniform File Code (UFC): 8205

Disposition Authority:	Retention Period:
A17-30-c-1	**Until dismantlement or disposal of facility, equipment, system, or process; or when superseded or obsolete, whichever is earlier.** **EPI**

EDF pertains to NRC licensed facility or INEEL SNF program?: ☐ Yes ☒ No

9. Registered Professional Engineer's Stamp (if required)



Conclusion:

The water erosion rates were calculated based on the Universal Soil Loss Equation (USLE) which is commonly used to predict longtime average soil loss runoff rates from a site. Wind erosion rates were calculated using an equation for estimating soil emissions from storage piles. It should be noted that this and other available methods for calculating wind erosion are based on short-term durations and may not be valid for the design life of the cover. However, previous studies by Hackett et al., 1994 and Keck, 1995, indicate that the area around RWMC has experienced soil deposition and little to no erosion in the past 10,000 years. The studies indicate this area appears to be a good prospect that this situation (of essentially no erosion) will continue at least until the next glacial period. The design life of the protective soil cover is189 years, which is the institutional control period. The water erosion for the soil cover top is 0.06 inches of soil and 1.3 inches of soil for the side-slopes over the 189-year period. The wind erosion for the soil cover top is 0.0008 inches and 0.0014 inches of soil for the side-slopes over the 189-year period. The water and wind erosion calculations indicate that the cover and sideslopes should not experience erosion that would detrimentally impact the integrity of the engineered cover, therefore the cover and sideslopes should remain stable for the duration of the institutional control period.

References:

1. Central Facilities Area Sewage Treatment Plant Drain Field (CFA-08) Protective Cover Infiltration Study, EDF-2696, May 2001.

2. Erosion and Sediment Control, The American Society of Civil Engineers (ASCE)

3. Climatography of the Idaho National Engineering Laboratory, DOE/ID-12118, December 1989

4. CFA Precipitation Data from 1950-1999 of NOAA Data, spreadsheet from Jestin Hurst

5. Hackett, W.R., J. A. Tullis, R. P. Smith, S. J. Miller, T. V. Dechert, P. A. McDaniel, and A. L. Falen, 1994, "Geologic Processes in the RWMC Area, INEL: Implications for Long Term Stability and Soil Erosion at the RWMC", EGG-WM-11430.

6. K. N. Keck, 1995, SDA Surface Water Description and Data, EDF ER-WAG7-66, EG&G Idaho, Inc.

WATER EROSION_top of cover

Universal Soil Loss Equation (USLE):

A= R*K*LS*C*P

where:

A= annual soil loss due to erosion (tons/acre/yr)
R= rainfall factor
K= soil erodibility factor
LS= topographic factor derived from slope length and slope gradient
C= cover and management factor
P= support practice factor

		CFA-08	
R=	20 from Reference 1	**Soil Cover top:**	
K=	0.22 from Reference 1	Lincoln Blvd Borrow Source Soil averages:	32.65% sand
			35.40% silt
			26.05% clay
			0 = %OM
			2 = soil structure
			4 = permeability

$LS= [L/72.6]^{M}*[65.41*\sin^2(S)+4.56*\sin(S)+0.065]$

L= length of flow path of contributing area (ft)
M= 0.6*[1-exp(-35.835*s)]
s= slope (ft/ft) of contributing area
S= average slope (degrees) of contributing area

slope =	0.5 %
L=	101 ft
M=	0.10
s=	0.005
S=	0.29 deg.
LS=	0.09

For established native grass:

C=	0.13 from table 1 - assume 35% plant surface coverage
P=	1

Annual Soil Loss Due To Water Erosion (Lincoln Blvd Borrow Source Soil)

A= **0.05 tons/acre/yr**

Calculate Annual Soil Loss (A) in terms of inches:

Assume soil density = 100 lb/1 ft^3
Cover needs to last for 189 yrs = Institutional Control Period
= A (tons/acre/yr) * (2000lbs/ton) * (1acre/43560ft^2) * (1ft^3/100lb) * (12in/ft) * 189 yrs
= 0.06 inches of soil erosion due to rainfall over 189 years for the soil top cover

WATER EROSION_cover side-slopes

Universal Soil Loss Equation (USLE):

A= R*K*LS*C*P

where:

A= annual soil loss due to erosion (tons/acre/yr)
R= rainfall factor
K= soil erodibility factor
LS= topographic factor derived from slope length and slope gradient
C= cover and management factor
P= support practice factor

		CFA-08	
R=	20 from Reference 1	**Soil Cover side-slopes:**	
K=	0.46 from Reference 1	Spreading Area A[1] Borrow Source Soil averages:	9.90% sand
			65.20% silt
			24.9 clay
			0 = %OM
			2 = soil structure
			4 = permeability

$LS= [L/72.6]^{M}*[65.41*\sin^2(S)+4.56*\sin(S)+0.065]$

L= length of flow path of contributing area (ft)
M= 0.6*[1-exp(-35.835*s)]
s= slope (ft/ft) of contributing area
S= average slope (degrees) of contributing area

slope =	10 %
L=	60 ft
M=	0.58
s=	0.1
S=	5.71 deg.
LS=	1.04

For established native grass:

C=	0.13 from table 1 - assume 35% plant surface coverage
P=	1

Annual Soil Loss Due To Erosion (Spreading Area A Borrow Source Soil)

A= 1.25 tons/acre/yr

Calculate Annual Soil Loss (A) in terms of inches:

Assume soil density = 100 lb/1 ft^3
Cover needs to last for 189 yrs = Institutional Control Period
= A (tons/acre/yr) * (2000lbs/ton) * (1acre/43560ft^2) * (1ft^3/100lb) * (12in/ft) * 189 yrs
= 1.30 inches of soil erosion due to rainfall over 189 years for the soil cover side-slopes

[1]The borrow source for the cover side-slopes has not been determined, therefore, Spreading Area A soil properties were used as a representative soil.

WIND EROSION_top of cover

Quantification of Soil Loss by Wind Erosion:

For Storage Piles use the following equation

E = 1.7*[s/1.5]*[(365-p)/235]*[f/15]

where:

E = Total suspended particulate emission factor, lb/day/acre
s = Silt content of aggregate, %
p = Number of days/year with > 0.01 inches of precipitation
f = Percentage of time that the unobstructed wind speed exceeds 12 mph at the mean pile height

CFA-08
Soil Cover top (Lincoln Blvd Borrow Source):

Soil averages: 32.65% sand, 35.40% silt, 26.05% clay

s = 0.354
p = 68.1 (from Reference 4)
f = 0.12 (from Reference 3)

Annual Soil Loss Due To Wind Erosion (Lincoln Blvd Borrow Source Soil)

E = 0.0041 lb/day/acre

Calculate Soil Loss (E) in terms of inches:

Assume soil density = 100 lb/1 ft^3

Cover needs to last for 189 yrs = Institutional Control Period

= E (lb/day/acre) * (1acre/43560ft^2) * (1ft^3/100lb) * (12in/ft) * (365 days/yr) * 189 yrs

= **0.0008 inches of soil erosion due to wind over 189 years for the soil cover top**

NOTE: This equation for wind erosion does not account for the reduction in erosion forces due to vegetation cover, nor does it account for any wind blown deposition of material.

WIND EROSION_cover side-slopes

Quantification of Soil Loss by Wind Erosion:

For Storage Piles use the following equation

E = 1.7*[s/1.5]*[(365-p)/235]*[f/15]

where:

E = Total suspended particulate emission factor, lb/day/acre
s = Silt content of aggregate, %
p = Number of days/year with > 0.01 inches of precipitation
f = Percentage of time that the unobstructed wind speed exceeds 12 mph at the mean pile height

CFA-08
Soil Cover side-slopes (Spreading Area A[1] Borrow Source):

Soil averages: 9.90% sand, 65.20% silt, 24.9 clay

s = 0.652
p = 68.1 (from Reference 4)
f = 0.12 (from Reference 3)

Annual Soil Loss Due To Wind Erosion (Spreading Area A Borrow Source Soil)
E= 0.0075 lb/day/acre

Calculate Soil Loss (E) in terms of inches:
Assume soil density = 100 lb/1 ft^3
Cover needs to last for 189 yrs = Institutional Control Period
= E (lb/day/acre) * (1acre/43560ft^2) * (1ft^3/100lb) * (12in/ft) * (365 days/yr) * 189 yrs
= **0.0014 inches of soil erosion due to wind over 189 years for the soil cover side-slopes**

NOTE: This equation for wind erosion does not account for the reduction in erosion forces due to vegetation cover, nor does it account for any wind blown deposition of material.

[1]The borrow source for the cover side-slopes has not been determined, therefore, Spreading Area A soil properties were used as a representative soil.